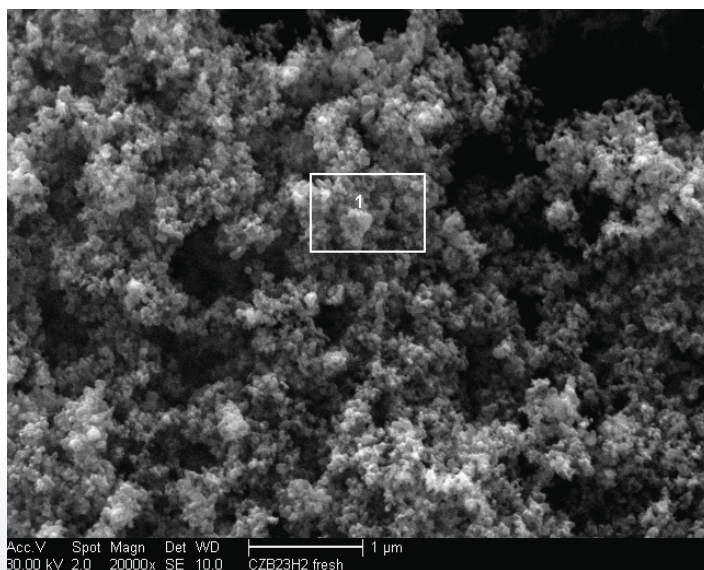


Catalysts for Alcohol Production from CO₂ and CO

The Idaho National Laboratory has produced multi-functional catalysts for selective CO and CO₂ hydrogenation to alcohols. This novel catalyst allows for higher activity than commercial catalysts and can be synthesized to produce methanol and higher alcohols such as ethanol, propanol and butanol in a single process.

Current commercial catalysts have poor low temperature activity and are only applicable to carbon monoxide-rich feedstocks. In addition, literature searches indicate that no catalysts have been commercialized for hydrogenation of carbon dioxide-rich feedstocks. The catalyst preparation method developed results in stable catalysts with unique morphologies and surface properties. The technology is patent pending and INL is seeking non-federal partners who are interested in further studying or licensing and commercializing the technology.



Scanning electron microscope image of a copper/zinc oxide alcohol synthesis catalyst prepared by the hydrothermal method

Background

Regardless of the controversies surrounding greenhouse gases, political and industrial analysts generally agree that at some point in the near future laws will be enacted that restrict CO₂ output. In addition, analysts also predict an increasing demand and limited supply. Further, ethanol and butanol markets are expanding due to demands caused by subsidies and blending requirements into liquid fuels. For example, the DOE Office of Biomass Program's goal is

to replace 30% of petroleum energy by 2030. However, current methods, such as biomass fermentation, are inherently inefficient regarding carbon utilization. Ethanol represents 34% of the carbon input, and the remaining carbon is exhausted as CO₂ from the fermentation offgas stream (17%) and lignin combustion (47%).

Catalysts for ethanol and butanol synthesis have been investigated for many decades. In general, catalysts for alcohol synthesis may be classified into three broad groups:

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a) modified Fischer-Tropsch catalysts; examples are cobalt or iron catalysts modified with copper, nitridized iron, and alkalized iron or cobalt catalysts;

b) modified methanol synthesis catalysts; these catalysts are modified by incorporating alkali metals; and

c) other catalysts such as supported rhodium or molybdenum, chromium oxide and manganese oxide promoted by alkali oxides or carbonates.

Catalysts in these three areas are all active for the production of alcohols. The selectivity of each of these catalysts to a particular alcohol is dependent on the catalyst composition

(including the alkali-metal promoter), as well as the reaction testing conditions employed.

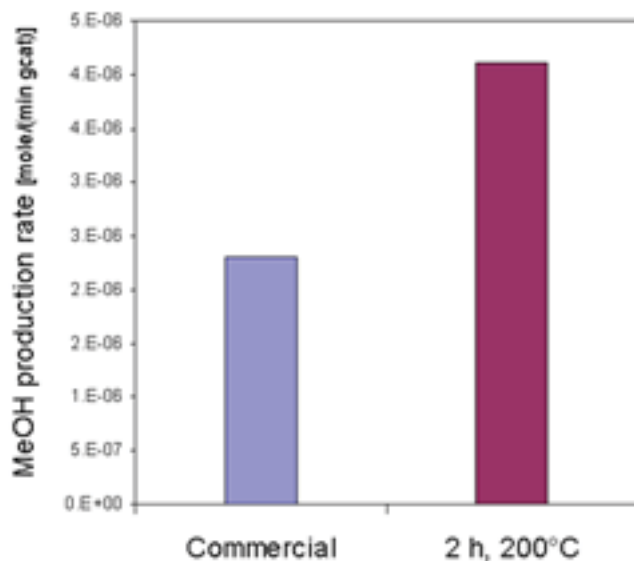
Solution

Researchers at the INL are developing novel catalysts with the understanding that current processes use multiple steps and are inefficient in converting hydrogen and carbon oxides into value added fuels and/or chemicals. INL researchers recognized that producing alcohols via a catalytic process from biorefinery could more than double the fuel output. They also realized that a simple one-step, small scale, catalytic process was needed because biorefinery plants are highly distributed.

INL researchers focused on catalysts based on nano-materials with metal/metal oxide structures to suppress active site agglomeration. Researchers have been successful in developing a highly active, low temperature catalyst, which appears to be ideal for use onsite at biorefineries.

INL's low temperature catalysts greatly improves energy efficiency and significantly reduces pressure and equipment requirements. Research and development of the catalyst is ongoing and the INL is seeking interested parties to collaborate in the development and commercialization of these novel catalysts.

Methanol Production Rate on
Nanoparticle Catalysts
Feed composed by $\text{CO}_2\text{H}_2\text{:Ar}$ (2:6:3)



Selectivity to Methanol on Nanoparticle
Catalysts
Feed composed by $\text{CO}_2\text{H}_2\text{:Ar}$ (2:6:3)

